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(54) Mechanical system for suspending, connecting and inclining loudspeaker enclosure line arrays

(57) The invention regards a mechanical system for suspending, connecting and inclining loudspeaker enclosures in line, which includes a pair of link bars (16) for connecting the two sides of the enclosures, starting from a suspension or support frame, and a pair of adjustment bars (17) for rear connection of the line of enclosures. The link bars of each pair of consecutive enclosures are joined together to form the enclosures' oscillation axis, whereas the adjustment bars set and fix the inclination of each enclosure by means of its oscillation on the aforementioned axis.

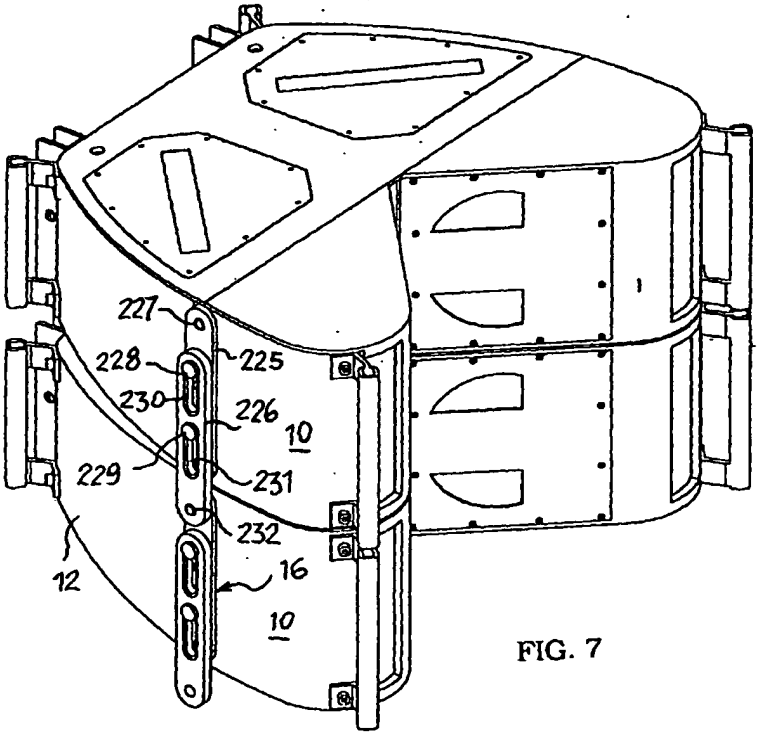

FIG. 7

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Description

Field of Invention

[0001] This invention regards the loudspeaker enclosure sector in general and refers in particular to a system for supporting or suspending (supporting a Stacked System or suspending a Flying System), connecting and adjusting the inclination (splay) of multiple loudspeaker enclosure systems, in a line array configuration).

Prior Art

[0002] A patent by this applicant described among other things a loudspeaker enclosure with a parallelepiped-shaped body, a substantially trapezium-shaped footprint, without a front part, which means that, viewed from the front, it has a centre cavity with sides but open at the top and bottom, in other words unobstructed by walls above or below. At the rear of the cavity, there's an emission slot for a high frequency waveguide. The mid and low frequency loudspeakers are mounted in the side walls of the cavity, positioned symmetrically in relation to the emission slot.

[0003] The lack of top and bottom sides in the area corresponding to the front cavity excludes any negative effects, such as interference due to reflections from parallel or diverging surfaces, which these sides would otherwise have formed. This enables a real unbroken sound line to be formed for all frequencies reproduced, in the event of several enclosures being used one above the other (in a line array) and also when the enclosures must be inclined in relation to each other, for vertical coverage requirements.

[0004] But, as well as the abovementioned enclosures, more conventional loudspeaker enclosures with a body or box of any other shape, when positioned in line one above the other, may require the splay between them to be adjusted to optimize sound coverage.

Aim and Summary of the Invention

[0005] One aim of the invention is to provide a means with a high load-bearing capacity and guaranteed reliability for supporting and connecting the boxes of several loudspeaker enclosures in line, with the possibility of fine individual adjustment of inclination as required, even with a precision of ¼ of a degree or less.

[0006] Another aim of the invention is to provide mechanical means that are not costly to build, but can simplify and facilitate support, lifting, linking and inclination of several loudspeaker enclosures, and allow fine adjustment to be carried out in a simple practical manner.

[0007] These aims and advantages are achieved according to the invention with a mechanical connecting system, consisting essentially in a pair of link bars for connecting the two sides of loudspeakers enclosures in line (array), starting from a suspension or support frame, the link bars of each two consecutive loudspeaker enclosures being connected to create an oscillation axis orientated transversally to the enclosures' bodies or boxes, and a pair of adjustment bars for rear connection of the enclosures in line and to set and fix the inclination of each enclosure by its oscillation on this rotation axis, created by the link bars.

Brief Description of the Designs

[0008] The enclosed designs show examples of practical applications of the mechanical system as per the invention and are hereafter described in detail. In these designs:

Fig. 1 shows an exploded view of the suspension components and connection of at least two loudspeaker enclosures;

Fig. 2 shows a view in perspective of several loudspeaker enclosures of different dimensions connected with the invention's system;

Fig. 2a shows an enlarged view of detail "a" circled in Fig. 2;

Fig. 2b shows an enlarged view of detail "b" circled in Fig. 2;

Fig. 2c shows an enlarged view of detail "c" circled in Fig. 2;

Fig. 2d shows an enlarged view of detail "d" circled in Fig. 2;

Fig. 3 shows separated (from the part mounted on one side of the enclosure) a pair of connecting bars for connecting the sides of enclosures one above another, which operates as a link and "hinge" between the two enclosures, in such a way as to enable them to be connected and inclined in relation to each other;

Fig. 3a shows the pair of bars in Fig. 3 when assembled;

Fig. 4 shows a separated pair of bars used for rear connection and for adjusting the inclination of loudspeaker enclosures one above another;

Fig. 4a shows a side view of the bars in Fig. 4 fitted together and graduated;

Fig. 5 shows an exploded view of a locking device for the enclosures' rear connector bars and corresponding to Fig. 2d; and

Fig. 5a and 5b show the device in Fig. 5 in locked and unlocked positions respectively;

Fig. 6 shows a different set-up of the side link bars for several enclosures one above another;

Fig. 6a shows an enlarged view of the detail circled in Fig. 6;

Fig. 7 shows a variation of the mechanical connection of the side link bars of several enclosures one above another;

Fig. 7a shows an enlarged view from the outside of the bars in Fig. 7 when they are connected with the

bar (dotted line) of an enclosure above;
Fig. 7b and 7c show, from the rear of the internal bar, a mechanical linking device of the bars as per Fig. 7 in the locked and unlocked positions respectively; and
Fig. 8a and 8b show a similar view of a variation of the bars' mechanical connecting device as per Fig. 7 in the locked and unlocked positions respectively.

Detailed Description of the Invention

[0009] The mechanical system proposed here can be used to support or lift and connect a line (line array) of loudspeaker enclosures 10, each with a body or box 11 with two side walls 12, a possible front cavity 13 with an emission slot at the end, and a rear wall 14, as well as to adjust the inclination between adjacent enclosures.

[0010] The system essentially includes a main suspension or support frame 15, a pair of link bars 16 to connect the enclosures at the side, a pair of adjustment bars 17 for the enclosures' rear connection and (splay) adjustment, and a support device 18 fitted on the rear wall of the enclosures and intended to hold, as well as lock/unlock, the pair of adjustment bars 17.

[0011] More in detail, the main frame 15 can be made from tubular components connected to form a 4-sided structure, and can be connected, for example in telescopic form, to at least one extension frame 15'. The main frame and extension frame are usually fitted with means for connecting a hoist for lifting when the line of enclosures must be suspended. At the sides of the main frame 15, there are auxiliary bars 19 to connect the first of a line of enclosures; on the sides of the extension frame 18, two additional bars 20 can be fitted, each with a shackle 21 for connecting tie-lines or pull-back cables for the line of enclosures, or two bars 22, each fitted with a flange 23 with two holes for fitting one or two shackles 24, according to needs.

[0012] In one type of set-up, the pair of link bars 16 includes, as can be seen in Fig. 3 and 3a of the designs, an internal bar 25, to be fitted (for example with screws) to the relative side wall 12 of the enclosure's body or box, and an external bar 26, which can be fitted with a handle 26'. Viewed vertically, the internal bar 25 has at least one hole at the top 27, a middle hole 28 and a bottom hole 29, whereas the external bar 26 has a top pin 30, middle pin 31 and bottom pin 32, which can have the same or different lengths. When the enclosure has a front cavity 13, the internal bar 25 is fixed to the body or box 11 level with the emission slot at the end of the enclosure's front cavity.

[0013] The pair of adjustment bars 17 includes, considering Fig. 4 and 4a of the designs, a left bar 33 and right bar 34, both of which have the same front toothing 35 and are turned through 180° to face each other and mesh into each other. Viewed vertically, the left bar 33 has a top hole 36 and a middle hole 37, whereas the right bar 34 has a slot 38 at its top end, a middle hole 39 and a bottom hole 40. The two adjustment bars 33 and 34 are fitted together, with the possibility of parallel movement, by means of a bolt 41 that passes through the slot 38 of one bar 34 and is screwed into a self-locking nut 42 recessed in the back of the other bar 33 at the height of a hole 43.

[0014] Support device 18 includes a C-shaped component 44 with a bottom wall, which is fastened vertically, for example using screws, to the rear wall 14 of the body or box of an enclosure, and two side walls forming a channel 45 into which the adjustment bars 17 are fitted. The device 18 also includes a sliding bolt 46, passing through a guide block 47 fitted on one side of the C-shaped component 44 and running crosswise to the parallel walls of this component.

[0015] The sliding bolt 46 is fitted with a grip knob 48 and can be moved from a retracted unlocked position - Fig. 5b, to a forward locked position -Fig. 5a - normally held by means of a relative return spring 49 and a safety lock, obtained by screwing a part 48' of the knob 48 into a threaded hole 50 in the head plate of the guide block 47.

[0016] Each loudspeaker enclosure is basically equipped with two pairs of side bars 16, part of which, the internal bar (25) is pre-fixed on the side of the body or box 11, and two pairs of parallel rear adjustment bars 17, each of which has a relative support device 18, which is also pre-fastened to the rear 14 of the body or box.

[0017] Multiple loudspeaker line arrays are thus connected by linking them by means of the side bars 16 and their position and inclination fixed by means of the rear adjustment bars 17.

[0018] More in detail, the first enclosure is connected to the main frame 15 by means of the additional bars 19, each fitting into the top hole 27 of the internal bar 25 of the pair of bars 16 and fastened on to the frame 15. The enclosures are then linked in line using the external bar 26 of each pair of link bars 16. This is done by fitting - Fig. 2 and 3a - the top pin 30 and middle pin 31 of each external bar 26 respectively into the middle hole 28 and bottom hole 29 of the internal bar on the uppermost enclosure and its bottom pin 32 into the top hole 27 of the internal bar mounted on the next enclosure down. Once they are connected, the internal 25 and external 26 bars are tightly fastened to prevent them separating. This fastening is carried out by means of a locking element 51 operating like a guillotine on one of the pins (31) of the external bar 26, to prevent it from sliding out of the relative hole (29) in the internal bar 25, said element being held in the locked position by means of a relative spring 52 -Fig. 3.

[0019] It should be noted that the connection of the bottom pin 32 of the external bar with the top hole 27 of an internal bar 25 of the next enclosure forms a oscillation axis, orientated across the body of the enclosure and enabling the inclination of the latter to be adjusted as required

[0020] Inclination is adjusted by means of the pair of toothed bars 17. One of these bars (for example 33) is fitted to the support device 18 mounted on the body or box of a first enclosure 10, and the other bar 34 fitted to the support device 18 of the next enclosure adjacent to the first one. Bars 33 and 34 are fixed to the relative support device by means of a sliding bolt 46 passing through a hole in the bars in question. Now, moving the bars along each other, thanks to the slot 38 and appropriately meshing the teeth of one bar with the those of the other at various levels, the enclosures' inclination can be varied by oscillating them on the axis formed (as explained above) by the pin 32 of each external bar 26 in the top hole 27 of the internal linking bar 25.

[0021] The pitch of the teeth of the adjustment bars 33 and 34 is preset in order that moving one bar along the other by one tooth gives a certain variation in the inclination (for example of 0.5°) of one enclosure in relation to the other, in order to precisely set the vertical orientation of the enclosures within a multiple set-up. Changing the centre distance between the bars' teeth and the holes through which the sliding bolts pass, angles smaller than the minimum measurement can also be obtained, by alternating bars in which this centre distance is different from the previous ones. In this manner, for example, with five different types of bars, it is possible to achieve an adjustment as precise as 0.1 ° between enclosures.

[0022] In a set-up such as that shown in Fig. 6 and 6a, and bearing in mind the aims to be achieved, the pair of linking bars 16 includes an internal bar 125 with a top hole 127 and two front pins (one middle 128 and one bottom 129), whereas the external bar 126 has a top slot 130, a middle slot 131 and a bottom hole 132. The middle pin 128 and bottom pin 129 of the internal bar 125 pass (and can slide) through the top slot 130 and middle slot 131 of the external bar 126 and have a head that keeps the external bar permanently attached to the internal bar.

[0023] This type of set-up offers the advantage of enabling the external bar (thanks to its slot) to slide along the internal bar fixed to the enclosure and be moved into a retracted position, level with and coinciding with the internal bar, without protruding downwards from the enclosure's body when it's transported and when it's not connected to another one, and in a extended position, protruding downwards from the enclosure's body when it's placed on another one and connected to it.

[0024] The connection of enclosures one above the other is therefore carried out - Fig. 6 - by sliding the external bar of an upper enclosure until its bottom hole 132 coincides with the top hole 127 of the following enclosure's internal bar - Fig. 6a- in order to be able to fit a safety pin 151 into the matching holes, fixing the connection and setting the axis of oscillation of the relative enclosure.

[0025] In the set-up method shown in Fig. 7, 7a, 7b and 7c, and correspondingly in Fig. 8a and 8b, the pair of link bars once again includes an internal bar 225 and an external bar 226, which are matched and joined face to face again by means of two front pins, 228 and 229, coming out of the internal bar and fitting into the top slot 230 and middle slot 231 on the external bar 226.

[0026] The internal bar 225 also has a top hole 227 and bottom hole 227', whereas the external bar 226 has a bottom hole 232. In the top 227 and bottom 227' holes of the internal bar, two pins 260 and 260' pass and emerge from the rear outwards. These pins can be moved from a retracted unlocked position, normally held by a return spring 261, 261' for each pin, to a forward locked position controlled by a device 262, mounted on the rear side of the internal bar, which can be used from the outside, from the front of the external bar 226.

[0027] In a version such as that shown in Fig. 7b and 7c, this device 262 is of the "cremone" type, is controlled by means of a key 263 and manages to move, by means of wedge-shaped link and thrust elements 264, the pins for their movement from the retracted unlocked position to the forward locked position, against the effect of the return springs.

[0028] In the version shown in Fig. 8a and 8b, the control device 262 includes (in a box 270) a cog - not shown - which is moved by a key that controls two half-shafts 272, facing in opposite directions and each bearing a thrust cam 273 at the level of a corresponding pin 260, 260'. This means that turning the said half-shafts (and with them the thrust cams) results in a corresponding movement of the pins from the retracted unlocked position to the forward locked position against the action of the relative return springs.

[0029] The two pins can be move simultaneously, or one pin (normally the lower one) can be moved before the other. This staggered movement of the pins 260 and 260' can be achieved, for example, with an appropriate choice of the relative wedge-shaped (264) or cam (273) thrust devices, or by using two pins of different lengths.

[0030] With both the devices in Fig. 7b, 7c and 8a, 8b, when the pins 260, 260' are retracted into the unlocked position, the external bar 226 can be moved to the level of the internal bar 225, in order to prevent it protruding below the body of the enclosure, to avoid obstructing its transport or standing. When the enclosures positioned one above the other are being linked, the external bar 226 of the uppermost enclosure is moved downward until its bottom hole 232 coincides with the top pin 260 mounted in the internal bar 225 of the enclosure immediately below. At this point, the control device 262 is used to move the pins 260, 260' forward into the locked position on the internal bar. The top pin 260 will enter the bottom hole 232 of the external bar 226 of the uppermost enclosure, forming the oscillation axis of one enclosure on the other. So, the bottom pin 260' will enter a slot in the external bar 226 fitted to the internal bar 225 carrying the pins themselves, thus forming the mechanical connection of the adjacent enclosures.

[0031] To disconnect the enclosures later, it is suffi-

cient to carry out the opposite procedure with control device 262 to return the pins to the retracted unlocked position.

Claims

1. Mechanical system for the suspension, connection and inclination of loudspeaker enclosures in line, where each loudspeaker enclosure has a body or box (11) with two side walls (12), possibly a front cavity (13) with an emission slot at the end and a rear wall (14), **characterised in that** it comprises a pair of link bars (16) for connecting the two sides of the enclosures in line (array), starting from a frame for suspension or stacking, the link bars of each pair of consecutive enclosures being joined to form an oscillation axis orientated transversally to the enclosures' body or box, and a pair of adjustment bars (17) for a rear connection of the enclosures in line and to set and fix the inclination of each enclosure by means of an oscillation thereofon this rotation axis formed by the link bars.

2. Mechanical system as in claim 1, wherein the pair of link bars (16) includes an internal bar (25) to be fastened to a side wall (12) of the body or box of the enclosure, and an external bar (26), wherein, viewed vertically, the internal bar (25) has at least one hole at the top (27), a middle hole (28) and a bottom hole (29), and the external bar (26) has a top pin (30), middle pin (31) and bottom pin (32), and wherein the top pin (30) and middle pin (31) of the external bar are fitted respectively into the middle (28) and bottom (29) holes of the internal bar on the above enclosure and the bottom pin (32) of this external bar is fitted into the top hole (27) of the internal bar fixed on the next loudspeaker enclosure, the connection of this bottom pin (32) of the external bar with the aforementioned top hole (27) of said internal bar on the next loudspeaker enclosure forming the oscillation axis of the relative enclosure.

3. Mechanical system as in claim 2, wherein the pair of link bars (17) is used with a locking element (51) which holds one of the pins (31) of the external bar (26) to prevent it from slipping out of the relative hole (29) in the internal bar (25), said element being held in the locked position by a relative spring (52).

4. Mechanical system as per claim 1, wherein the pair of link bars (16) includes an internal bar (125) to be fixed to a side wall (12) of the body or box of the enclosure, and an external bar (126), where:

   the internal bar (125) has a top hole (127) and two aligned top (128) and bottom (129) pins,
   the external bar (126) has a top slot (130), a middle slot (131) and a bottom hole (132),
   the middle pin (128) and bottom pin (129) of said internal bar (125) pass, and can slide through the top slot (130) and middle slot (131) of the external bar (126) and have a head suited to holding the external bar attached to the internal bar,
   the bottom hole (132) of the external bar on the higher enclosure and intended to match the top hole (127) of the internal bar of an enclosure immediately below and receive a manual locking device also forming the oscillation axis of one enclosure in relation to another when the enclosures are one above another.

5. Mechanical system as in claim 4, wherein in the aforementioned matching holes (132, 127) of the external and internal bars (126, 125) of each pair of adjacent enclosures a removable connecting safety pin (151) is fitted, forming the oscillation axis of one enclosure on the other.

6. Mechanical system as in claim 1, wherein the pair of link bars (16) includes an internal bar (225) to be fixed to a side wall (12) of the body or box of the enclosure, and an external bar (226), where:

   the internal bar (225) has a top hole (227), two aligned front pins (228, 229) and a bottom hole (232),
   the external bar (226) has a top slot (230), middle slot (231) and bottom hole (232),
   the aligned pins (228, 229) of said internal bar (225) pass, and can slide, through the top slot (230) and middle slot (231) of the external bar (226) and have a head suited to holding the external bar against the internal bar,
   the bottom hole (232) of the external bar of an upper enclosure is intended to match the top hole (227) of the internal bar of an enclosure immediately below and receive a manually controlled locking device also forming the oscillation axis of one enclosure in relation to another when the enclosures are one above another.

7. Mechanical system as in claim 6, wherein two pins (260, 260') pass from the rear outwards through the top and bottom holes (227 and 227') of the internal bar, said pins being movable from a retracted unlocked position, normally held by a return spring (261, 261'), to a forward locked position set by a control device (262) mounted on the rear side of the internal bar, recessed in the enclosure body and able to be controlled from the front of the external bar (226), said pins, when in the locked position, fitting into the top hole (232) and a slot (231) in the external bar of an adjacent enclosure.

8. Mechanical system as in claims 6 and 7, wherein said control device includes a device controlled with a key and used to cause movement in opposite directions of wedge-shaped components located at the level of said pins to move the latter from the unlocked position to the locked position.

9. Mechanical system as in claims 6 and 7, wherein said control device includes devices controlled with a key and used to cause the rotation of two half-shafts facing in opposite directions and each with a turning cam element at the level of a respective pin for its movement from the unlocked position to the locked position.

10. Mechanical system as in any one of the previous claims, wherein in the enclosures that have a front cavity with a sound emission slot at the end, the pairs of link bars are fitted to the sides of the body or box of each enclosure, level with the sound emission slot at the end of said front cavity.

11. Mechanical system as in claim 1 and any one of claims 2-10, wherein the pair of adjustment bars (17) includes a first bar (33) and a second bar (34), both with identical transversal front toothing (35) and facing once another to mesh together, in which the first bar (33) has a top hole (36) and a middle hole (37) and the second bar (34) has a slot (38) at its top end, a middle hole (39) and a bottom hole (40), in which the two adjustment bars (33, 34) are together, but with the possibility of parallel movement away from one another, by means of a bolt (41) that passes through said slot (38) of the second bar (34) and is screwed into a self-locking nut (42) recessed in the back of the first bar (33), and in which said adjustment bars are used with a support device (18) fixed on the rear wall of the body or box of the enclosure and are movable, fitting into one another with their teeth at various levels to set the inclination of the enclosures.

12. Mechanical system as in claim 11, wherein one of the said adjustment bars (33) is fixed to the support device (18) applied to the body or box of a first enclosure, while the other adjustment bar (34) is fixed to the support device (18) of a consecutive enclosure adjacent to the first.

13. Mechanical system as in claims 11 and 12, wherein said support device (18) consists in an element vertically fastened to the rear wall (14) of the body or box of an enclosure and which forms a channel (45) in which the adjustment bars (17) are fitted, and in which said device (18) is used with a sliding bolt (46) orientated transversally to the adjustment bars to lock them together in any position.

14. Mechanical system as in claim 5, wherein said sliding bolt (46) has a grip knob and can be moved from an unlocked position to a locked position of the adjustment bars, the unlocked position being set by moving the sliding bolt manually, whereas the locked position is set by a return spring (49) and a safety lock applied by screwing part of the knob into a threaded hole on the front of the bolt's guide block (50).

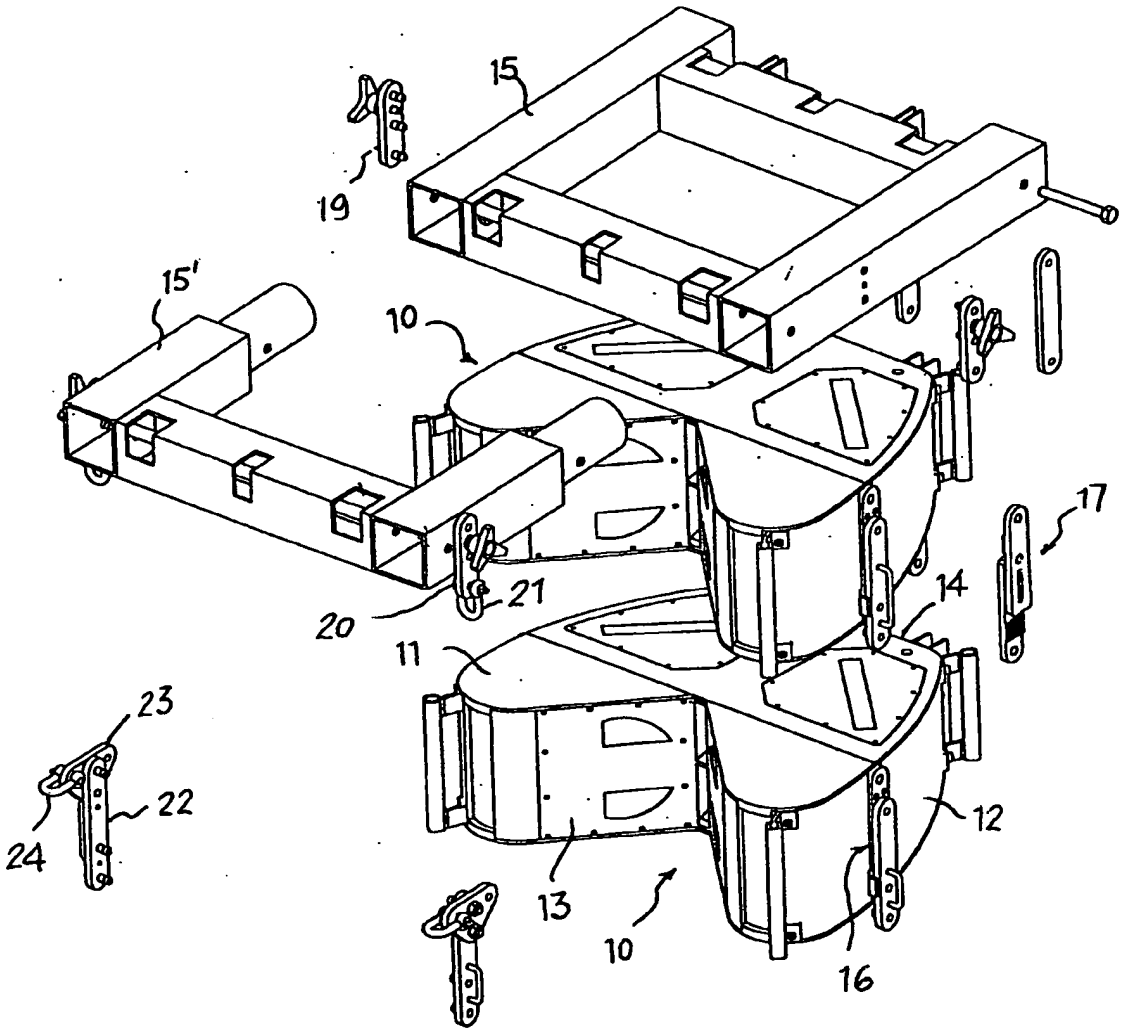


FIG. 1

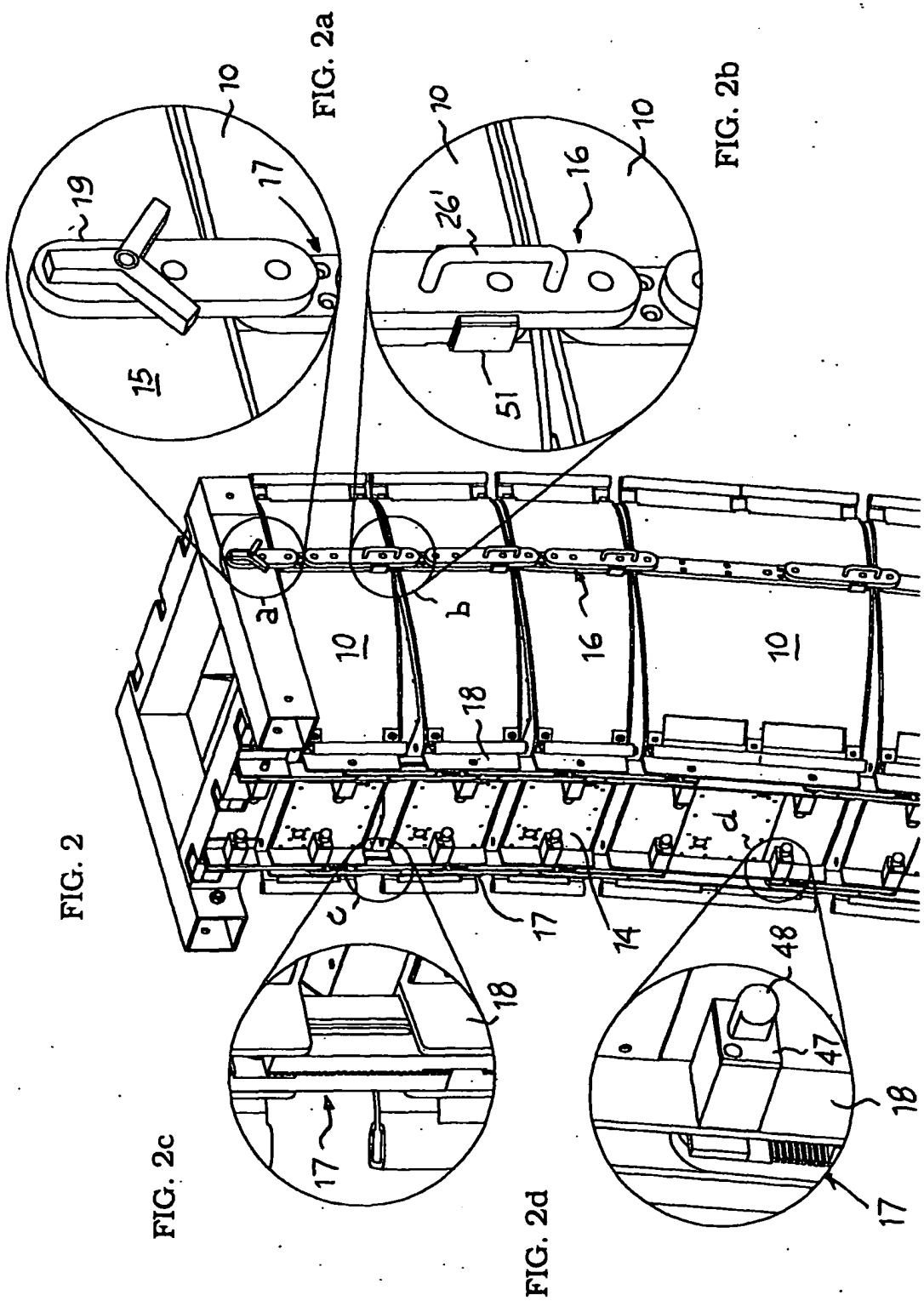


FIG. 2

FIG. 2a

FIG. 2b

FIG. 2c

FIG. 2d

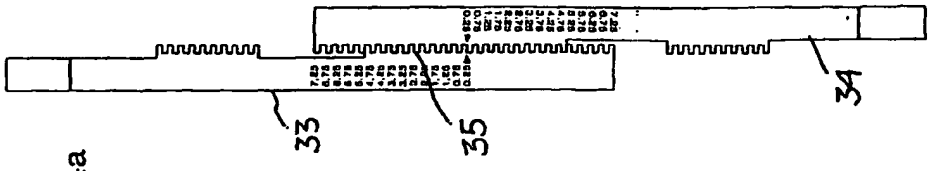


FIG.4a

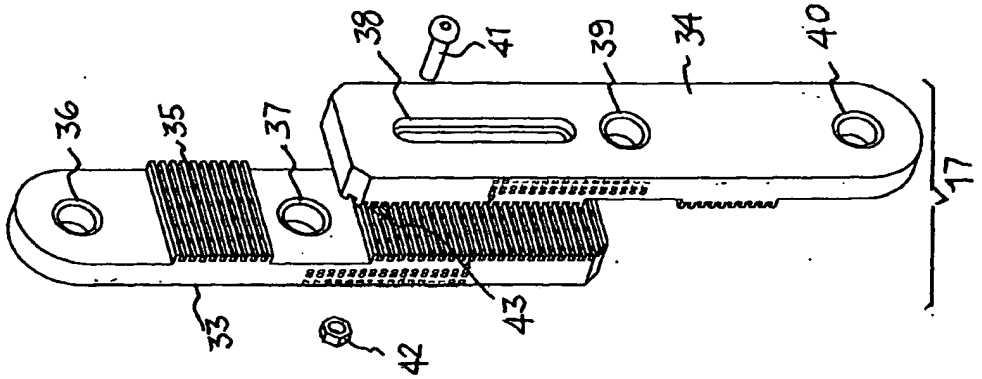


FIG. 4

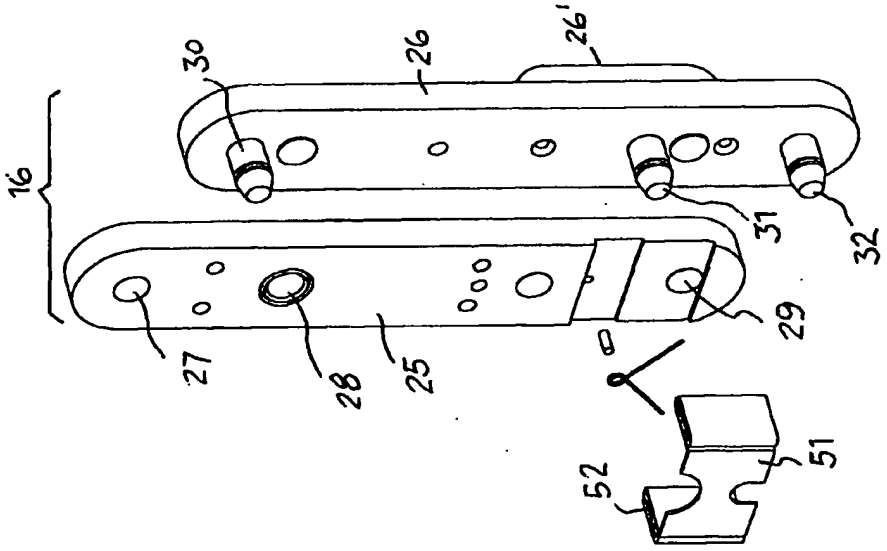


FIG. 3

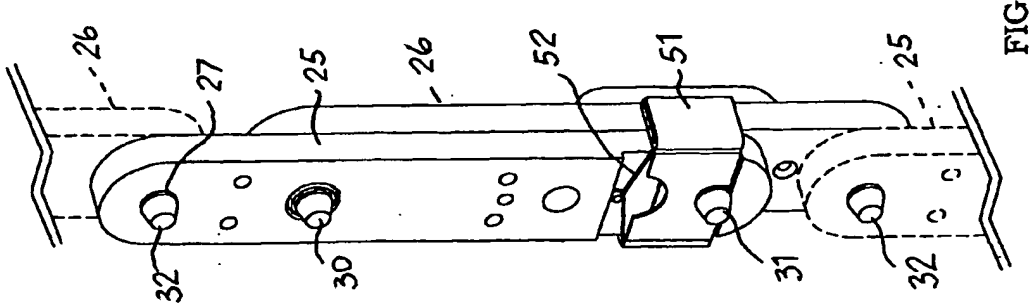


FIG.3a

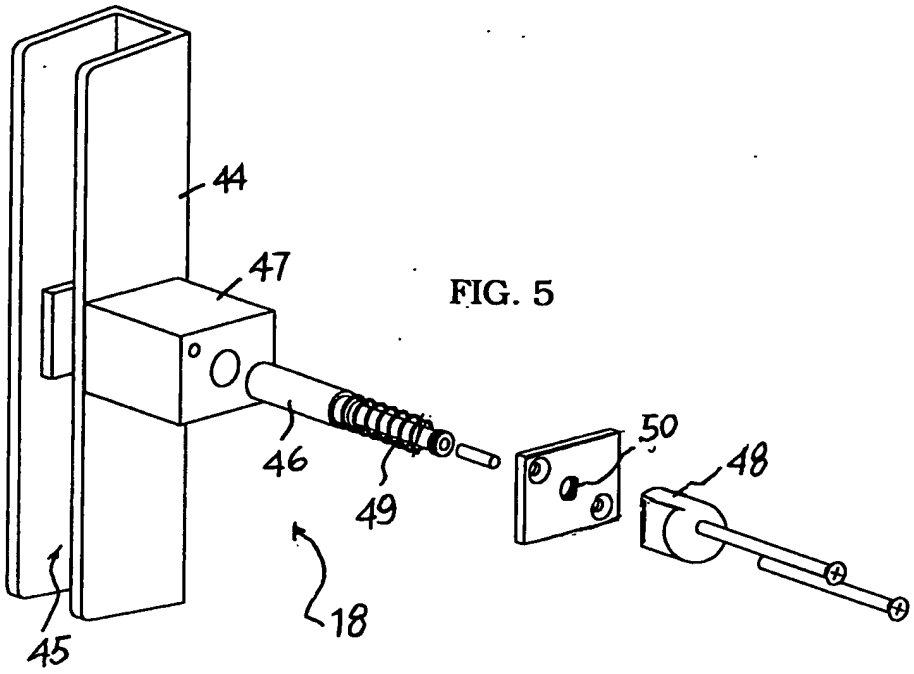


FIG. 5

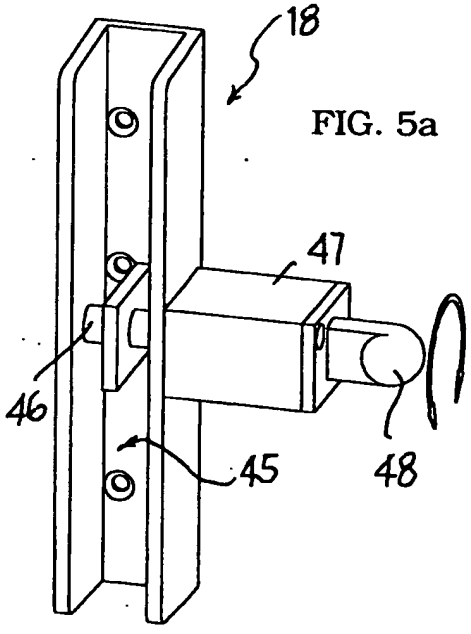


FIG. 5a

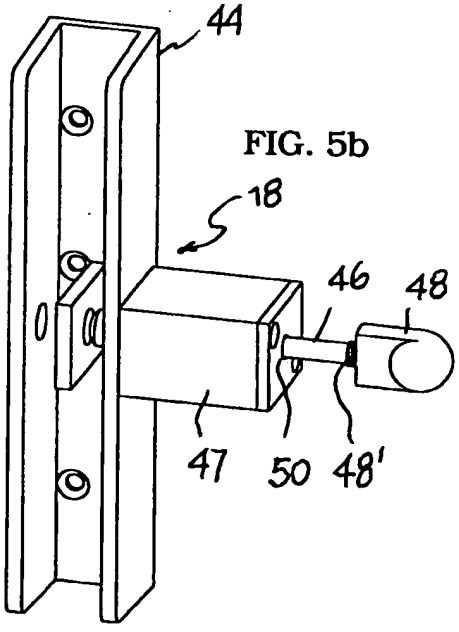


FIG. 5b

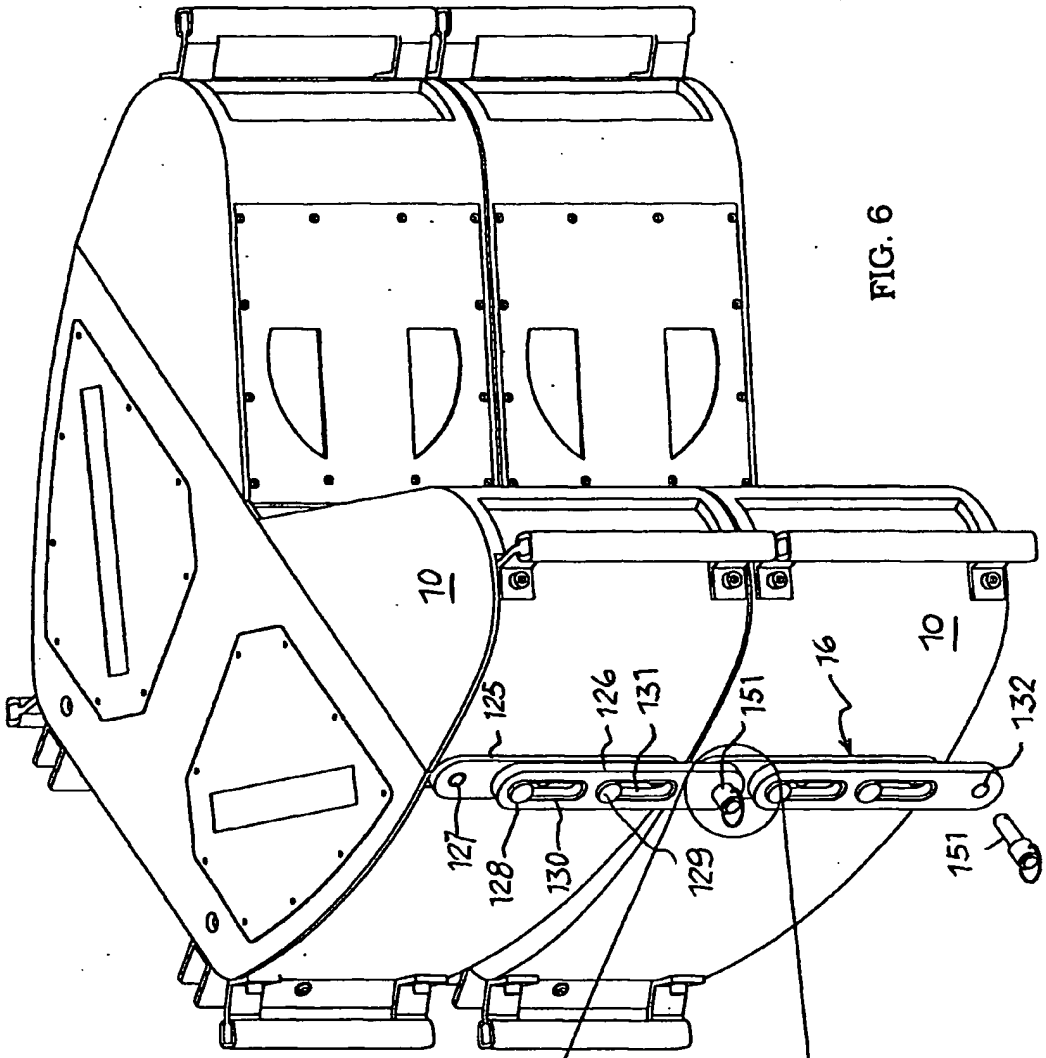

10
10
125
126
131
151
16
132
127
128
130
129
151

FIG. 6

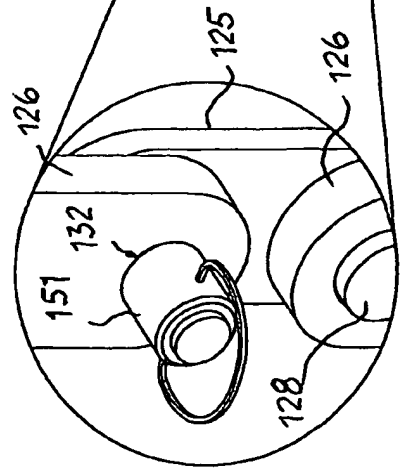

126
125
126
132
151
128

FIG. 6a

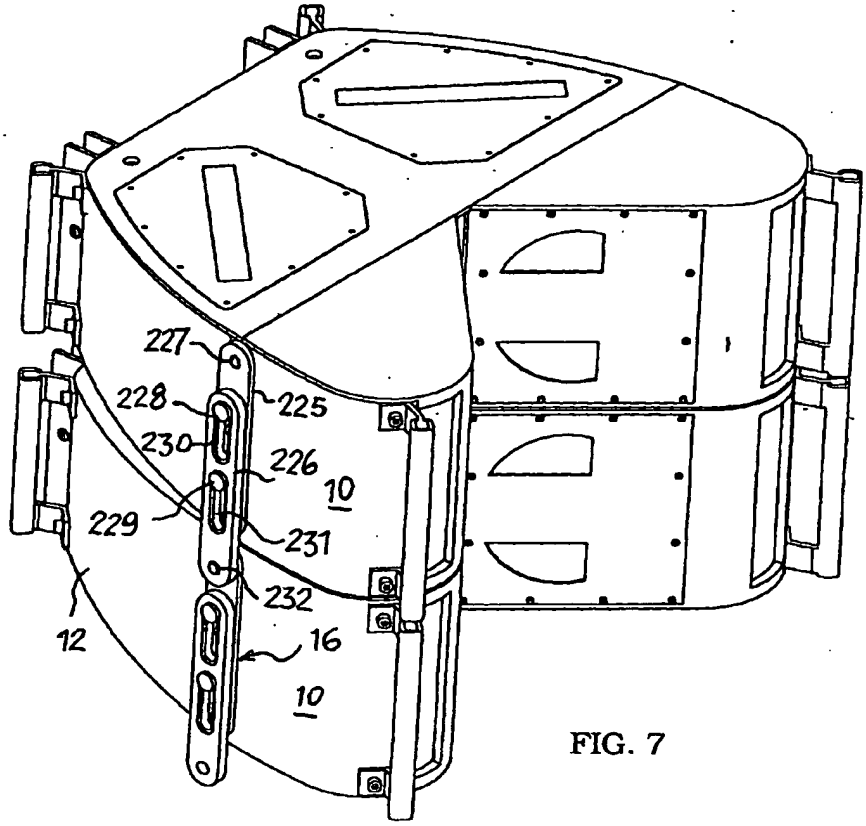
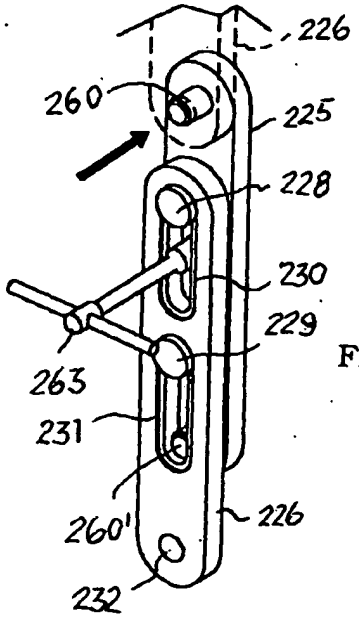

227
228
225
230
226
10
229
231
232
12
16
10

FIG. 7


226
260
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230
229
263
231
260'
226
232

FIG. 7a

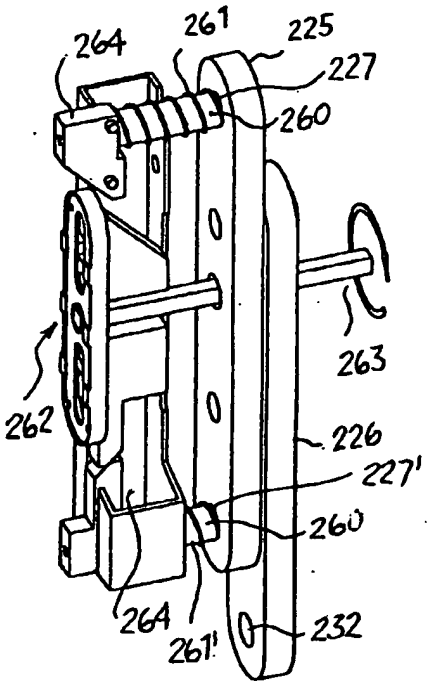

FIG. 7c

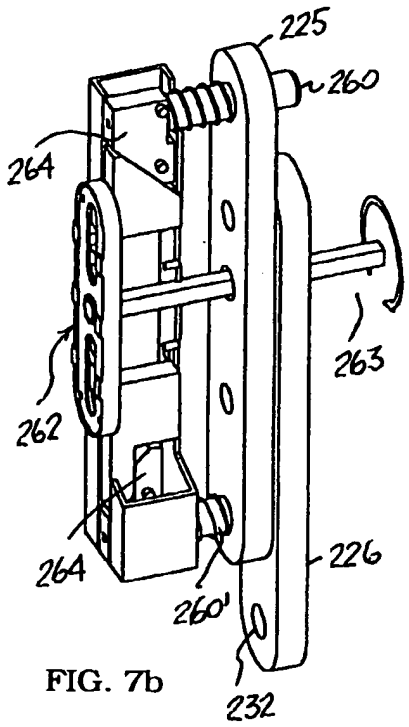

FIG. 7b

FIG. 8b

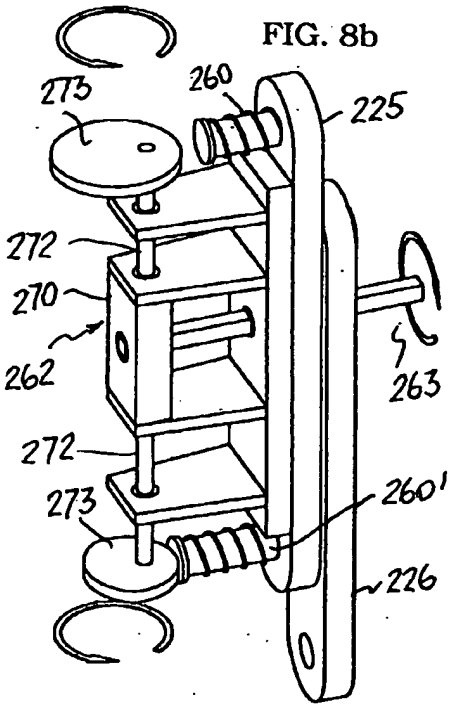

FIG. 8a